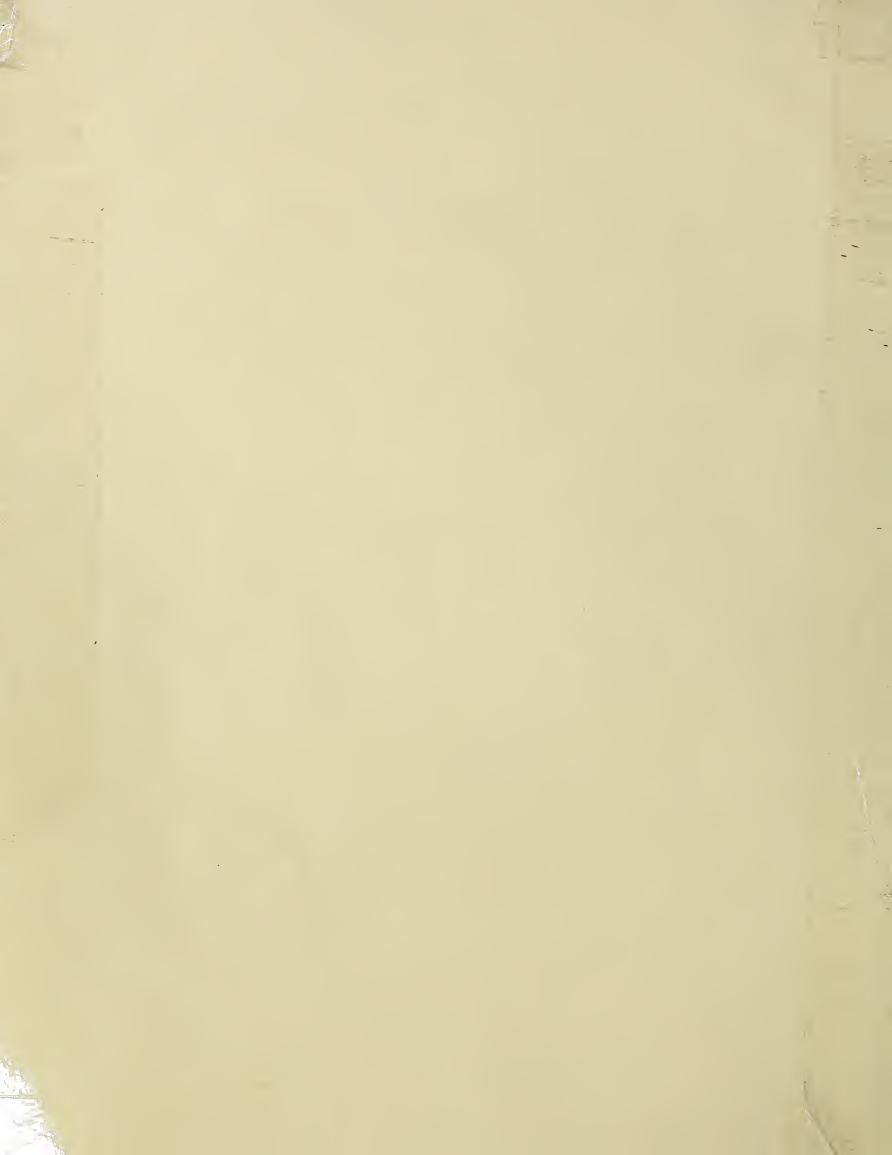
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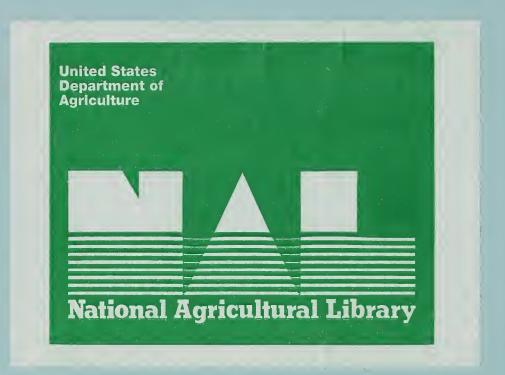


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TOWN OF HAMDEN, CONNECTICUT

FEBRUARY, 1964

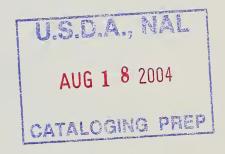


WATERSHED WORK PLAN

for

WATERSHED PROTECTION, FLOOD PREVENTION

AND RECREATION



FARM BROOK WATERSHED

TOWN OF HAMDEN, NEW HAVEN COUNTY, CONNECTICUT



WATERSHED WORK PLAN

FARM BROOK WATERSHED

Connecticut

Prepared under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666) as amended.

Prepared by:

Town of Hamden, Connecticut
New Haven County Soil and Water Conservation District

With assistance by:

U. S. Department of Agriculture, Soil Conservation Service
U. S. Department of Agriculture, Forest Service



TABLE OF CONTENTS

	Page
WATERSHED WORK PLAN	
SUMMARY OF PLAN	1-2
DESCRIPTION OF WATERSHED Physical Data Economic Data	3+6 3-5 5-6
WATERSHED PROBLEMS Floodwater Damage	6 - 7 6 - 7
PROJECTS OF OTHER AGENCIES	8
BASIS FOR PROJECT FORMULATION	8-9
WORKS OF IMPROVEMENT TO BE INSTALLED Land Treatment Structural Measures	9-11 9-10 10-11
EXPLANATION OF INSTALLATION COSTS	11,-13
EFFECTS OF WORKS OF IMPROVEMENT	13
PROJECT BENEFITS	14
COMPARISON OF BENEFITS AND COST	15
PROJECT INSTALLATION	15-16
FINANCING PROJECT INSTALLATION	16-17
PROVISIONS FOR OPERATION AND MAINTENANCE	18
TABLES	
Table 1 - Estimated Project Installation Cost	19
Table 1A- Status of Watershed Works of Improvement	20
Table 2 - Estimated Structural Cost Distribution	21
Table 2A- Estimated Construction Cost of Minimum Basic Facilities for Recreation	22
Table 3 - Structure Data	23

TABLE OF CONTENTS (continued)

	Page
Table 3A- Structure Data - Channel	24
Table 4 - Annual Cost	25
Table 5 - Estimated Average Annual Flood Damage Reduction Benefits	26
Table 6 - Comparison of Benefits and Costs for Structural Measures	27
Table 7 - Direct Benefits from Works of Improvement	28
INVESTIGATIONS AND ANALYSES Hydraulics and Hydrology Structure Investigations Stream Channel Improvement Geology Economics	29-33 29 29-31 31 31-32 32-33
PROJECT MAP - Figure 1	34
LAND USE MAP - Figure 2	35
RECREATIONAL DEVELOPMENT MAP - Figure 3	36

WATERSHED WORK PLAN

FARM BROOK WATERSHED

TOWN OF HAMDEN, CONNECTICUT

February 1964

SUMMARY OF PLAN

The Farm Brook Watershed of 2,930 acres is almost entirely within the Town of Hamden. The brook flows in a southerly direction to its confluence with Wintergreen Brook just below the Town of Hamden and City of New Haven boundary.

The sponsor is the State Commissioner of Agriculture and Natural Resources. The Hamden town government and the sponsor are concerned about flood problems and the need for developing open space areas for recreation and other purposes. Urgency for action is recognized because of existing flood hazards and imminency of losing needed sites and open space because of rapid urban expansion.

The major problem is the threat of serious flooding along the brook on about 80 acres of the intensively developed residential area below Benham Street. Studies indicate future average annual flood damages in excess of \$114,661 in this area unless protection is provided. The stream channel is not adequate to handle flows from a one-year frequency storm in many reaches.

At present there are no public outdoor swimming, or water associated picnic facilities in the town. The population of the town as of the 1960 Census was 41,056 and is expected to increase to 100,000 within fifty years.

The work plan includes two structures, a floodwater retarding structure and a multiple-purpose floodwater retarding-recreation structure. The structures will provide a total of 855 acre feet of floodwater storage and will control 57% of the total watershed. One mile of stream channel improvement is planned to provide further needed flood protection. The recreational development includes a 25 acre recreational pool with necessary space and minimum basic facilities for swimming, boating, picnicking and ice skating.

The total project cost is \$1,494,240 which includes construction, installation services, land rights, and administration of contract. Public Law 566 funds will bear \$626,923. Other funds, state and town, will bear the remaining \$867,317 of the total project cost. The time to accomplish the plan is five years.

	PL-566	Other	Total
Floodwater Retarding Structure	\$256,700	\$538,000	\$ 794,700
Stream Channel Improvement	176,475	158,000	334,475
Multiple-Purpose Structure and Recreational Development	193,748	171,317	365,065
Total	\$626,923	\$867,317	\$1,494,240

The average annual cost of flood prevention and the recreational development is \$81,881 including \$23,800 for operation and maintenance. The average annual benefits for flood prevention are \$123,882 which includes \$10,156 in Secondary Benefits and for the recreational development \$61,500 or a total of \$185,382. The benefit cost ratio is 2.3 to 1.0.

The watershed area is an important part of the Town of Hamden. The assessed valuation within the floodplain is approximately \$3 million. Schools, churches, fire and police protection, recreation facilities, present and future street patterns, and other services are established in a way that makes the area an integral part of the town. In addition to direct benefits mentioned above the project will prevent the floodplain from becoming a blighted area because of flooding and thus provide insurance against heavy public expenditure for urban renewal.

The Sponsor, who by state statute is responsible for operation and maintenance, will enter into an agreement with the Town of Hamden for the operation and maintenance of the structures and channel improvements.

Approximately 1,150 acres of the 2,930 acres in the watershed are now developed for residential purposes, and 900 acres are in woodland. The remainder consists of small areas of cropland, orchard, grasslands, and idle land. There are 15 farms in the watershed.

It is expected that by 1980 the watershed will be residential except for areas retained by the town for open space purposes. The town plans to acquire 210 acres for recreation and park areas. These lands along with 150 acres in the project reservoir areas, planned for flood prevention and recreational development, and park lands belonging to the City of New Haven will form an open space area of 500 acres, which is 30% of the watershed area above the structures.

DESCRIPTION OF WATERSHED

Physical Data

General: The Farm Brook Watershed of 2,930 acres (4.58 square miles) is almost entirely in the Town of Hamden and immediately north of the City of New Haven. It is bounded on the west by the Wintergreen Brook Watershed and on the east by the Mill River Watershed. The brook flows south to its confluence with Wintergreen Brook, a tributary of West River which flows into Long Island Sound at New Haven. The watershed is about 4.5 miles long and one mile wide. The relief is gentle to moderate with the exception of the West Rock Ridge portion. Elevations range from about 30 feet above sea level at the outlet to 650 feet at the extreme northern boundary.

Geology and Soils: Physiographically located in the Central Connecticut Valley, surficial deposits range from a predominance of heterogeneous boulder tills throughout most of the watershed to lesser deposits of stratified and non-stratified sands and gravels. These sand and gravel deposits were formed and deposited in temporary spillway controlled glacial lakes caused by the damming of meltwaters and in terrace systems as ice-contact slopes.

Two bedrock formations are found within the watershed. These are the New Haven Arkose which occupies most of the watershed area and conspicuous intrusive rocks in the extreme northern portions of the watershed. Both formations are of the Triassic Newark Group common to the Connecticut Valley. The New Haven Arkose is the sole bedrock formation which underlies or is present at any of the proposed works of improvement.

Soils in the watershed are primarily those associated with upland glacial tills representing almost 60 percent of the total soil cover. Lesser percentages are split near equally among terrace soils, shallow to bedrock soils, or swamps and poorly drained soils. The upland soils which have been developed on glacial till of varying thickness have been derived primarily from mica schists, gneisses, granites and locally some phyllite and are well drained. The terrace soils are well to excessively drained and have been derived from schists, gneisses and granites. A reddish color is the result of the Triassic red rocks throughout the watershed.

Floodplain: The floodplain begins immediately below the proposed floodwater retarding structure site. Five acres of the floodplain north of Benham Street are being rapidly developed for residential use. Part of the remaining fifteen acres that are zoned for commercial use are occupied by a local radio and television station.

The area south of Benham Street to the Wilbur Cross Parkway, consisting of fifty acres, was completely unoccupied five years ago. Since that time more than 100 homes have been built in the area.

The east and west branches of the brook join just before entering the Wilbur Cross Parkway Culvert which has a capacity of less than the ten-year storm discharge. The stream below the Parkway for about 1,000 feet is in a narrow floodplain. New housing has encroached on the stream in this area in the last two years.

Downstream about 1,500 feet below the Parkway, the stream is bordered by a street on one side and a community playground on the other. Channel capacity is less than that required to handle a two-year storm due to a limited bridge opening and poor channel alignment.

Approximately 2,000 feet below the Parkway, the floodplain broadens again. This portion was developed about 15-20 years ago and there has been continued encroachment on the stream by property owners.

Water: At present the only utilization of Farm Brook is as a natural drainageway. The New Haven Water Company supplies water to the area and the supply is estimated to be sufficient to meet the needs of future development.

In the upper half of the watershed the stream gradient ranges from 12 to 0.5 percent. From Benham Street south the gradient ranges from 0.8 to 0.2 percent.

Climate: The watershed is in the Prevailing Westerlies zone. The area is subject to periodical coastal storms, including the tropical hurricane type that move up the Atlantic Coast with heavy rainfalls.

The annual temperature range at the New Haven Airport, the closest weather station to the watershed, is from a winter low of -7°F to a summer high of 91°F. The frost-free period is about 190 days, from April 21 to October 28. The mean annual precipitation is approximately 45.0 inches, rather uniformly distributed throughout the year. Snowfall amounts and depths are not often an influencing factor in the precipitation pattern.

Land Use and Cover Conditions: Of the 2,930 acres in the water-shed approximately 1,150 acres are now developed for residential purposes. By 1980 it is expected that most of the 1,780 acres

now classified as open will be mostly built-up except for areas acquired for public open space. For purposes of description, the watershed can be divided at Benham Street - 1,865 acres are north of the street and 1,065 acres are south of it.

The area south of Benham Street is primarily limited to single-family dwellings with associated schools and churches. It is entirely developed except for 90 acres in a sand and gravel quarry area, and 25 acres of swamp land at the outlet of the watershed. When the quarry becomes inactive, the area will be leveled and developed for housing. The swamp is owned by the City of New Haven and development is not anticipated.

Of the 1,865 acres above Benham Street, 200 acres have been built-up in scattered housing developments. The remaining land is primarily woodland and a few farms. Woodland (900 acres) is the main land use, with small areas of cropland, orchard, grassland and idle land.

Economic Data

Population: The Connecticut State Development Commission has predicted a statewide population increase of 35% during the period 1960 to 1975. The population of Hamden as shown by the 1960 Census was 41,056.

Indications are that the watershed will exceed these population increase rates. An analysis reveals that during the past decade a 125 percent increase has been experienced. If the present rate of population growth in the watershed area is sustained, the area will be fully occupied in 25 to 30 years, and will house some 16,000 people.

Farms: There are about 15 farms in the watershed of which six are soil conservation district cooperators. Dairy, fruit and vegetable farming are the main enterprises. It is anticipated that by 1980, few if any of these farms will be in operation.

Woodland: Two major forest types are present: the oak-hickory type comprising 90 percent and the elm-red maple type comprising 10 percent of the woodland. This woodland is now used primarily for game management, aesthetic and recreational purposes. Housing and industrial site development is expected to reduce the present forest acreage over 50 percent.

More than 50 percent of the forest land in the watershed area is currently held in seven ownerships. Two of these tracts are publicly-owned. The City of New Haven, in their extension of

West Rock Park, owns 100 acres of woodland. The Town of Hamden owns 10 acres, partially forested. The remaining woodland is broken up into holdings that average under 10 acres.

Adequate forest fire protection is provided by the Connecticut State Park and Forest Commission in cooperation with the U.S. Forest Service through the Cooperative Forest Fire Control Program (C-M2). Other going Federal-State Cooperative Forestry Programs include: Cooperative Forest Management (CFM), Cooperative Forestation (C-N4), and Cooperative Forest Insect and Disease Control.

WATERSHED PROBLEMS

Floodwater Damages

The watershed does not have a history of serious floodwater damage because until recently the floodplain was relatively undeveloped. Since 1957 the area has developed rapidly. At present there are 150 homes within the floodplain subject to flooding. The stream channels are presently inadequate to handle flows which would result from a one-year storm and home owners are now experiencing damages annually.

The possibilities of increased flood stages and the resultant increase in damages are intensified because of the rapid urbanization of the now undeveloped parts of the watershed above the floodplain.

The average annual damages are estimated to be \$114,661. A flood of the magnitude of August 1955 storm, which was approximately of a 25-year frequency for this watershed would presently cause damages estimated at \$256,240.

Reach No. 1 - Damages in this reach result from flooding to a depth of four feet of lawns and walk-in basements of single-family homes.

There is a complete lack of a defined channel through the swamp which Farm Brook enters about 700 feet downstream from Woodin Street. This causes backwater which increases the flood stages associated with discharges in excess of one-year frequency flows.

Also, at the head of the reach, conditions are aggravated by the poor alignment and inadequate cross sectional area of Woodin Street Bridge. This combined with downstream channel conditions restricts the bridge capacity to flows of less than five-year frequency.

Reach No. 2 - This is a deeply entrenched area in which no damages occur.

Reach No. 3 - Annual flooding in this reach damages lawns and basements of single-family dwellings. Storms of tenyear frequency will put water into first floors and garages.

The capacity of the channel has been reduced by encroachment during residential development, and the Brook Street Bridge is a major constriction within the reach. The bridge is several hundred feet downstream from the foot of a relatively steep stretch of the brook where sediment has deposited from previous construction upstream. This combined with inadequate capacity of the bridge causes flows from runoff of two-year frequency storms to overflow along the streets and damage residential properties otherwise not vulnerable.

Reach No. 4 - Flood damages to lawns in this reach will occur from a two-year frequency storm and first-floor residential damages from a 10-year frequency storm.

Channel capacity through this damage area is reduced by backwater from a foot bridge and limited channel capacity downstream.

Reaches Nos. 5 and 6 - Flooding of lawns and streets occurs in these reaches annually, and a 30-year frequency storm will cause first-floor flood damages.

Limited culvert cross sectional area at several street crossings on a flat gradient in Reach 5 restrict channel capacity to yearly events. In addition to this there is a problem of backwater from the Wilbur Cross Parkway Culvert beginning with five-year storms. The capacity of this culvert is affected for flows in excess of a 30-year frequency storm by backwater from Gilbert Avenue Bridge and channel conditions downstream.

Reach No. 7 - No flood damages were evaluated in this reach.

Reach No. 8 - Flooding in Reach No. 8 will cause residential damages in the vicinity of Dunbar Hill Road.

The culverts under Dunbar Hill Road have limited capacity and are adversely affected by backwater from a private road crossing and outlet channel that is on a very flat gradient.

PROJECTS OF OTHER AGENCIES

There are no other projects which will affect or be affected by the Public Law 566 Project.

BASIS FOR PROJECT FORMULATION

This project work plan has been developed concurrently with overall planning for the town. The proposed floodwater retarding structures and the recreational development were coordinated with the objectives of the Town Planning Commission, Town Recreational Department and the Town Engineer. Likewise the plans for open space acquisition and development within the watershed by the town were worked out to fit and supplement the project objectives.

The primary objective of the Sponsor and the Town is to provide protection from floodwater for the built-up residential areas along the brook. The plan is based on a level of protection against floods expected to occur up to a frequency of about once in a hundred years. Faulure to provide this protection may result in loss of life, serious damage to 150 homes, and the need for costly repairs and clean-up of town streets and services. In addition to direct damages there is also concern by town officials that there would be a serious loss in tax base, and disruption of a significant segment of the town.

In addition to floodwater protection a major objective is to provide facilities for water related recreation for the growing population.

Two structures, a floodwater retarding structure and a multiplepurpose floodwater retarding-recreation structure, are planned
on the two physically and economically feasible sites available
in the watershed. It is planned to use the floodwater retarding
structure site to its maximum practical floodwater storage
capacity. Likewise, plans call for full utilization of the
multiple-purpose site based on the need for flood storage as
well as the recreational requirements of water supply and physical
conditions for swimming, picnicking, and boating.

To supplement the two structures and handle runoff from the builtup drainage area below Site No. 2, one mile of stream channel improvement is planned for the main channel.

The town recognizes that this development will meet only a small part of the need for public outdoor recreation in the area.

The town recognizes a need to retain open space in the upper watershed in addition to the areas required for the floodwater retarding structure and the recreational development. It is planned to acquire about 160 acres immediately above the floodwater retarding site to be utilized for a golf course and park. Adjoining the recreational development the town plans to acquire 50 acres to supplement the development and tie in with New Haven's West Rock Park.

Thus the open space acquisition by the town along with the project reservoir areas and the portion of West Rock Park will provide about 500 acres of land primarily in vegetative cover.

The costs for acquisition and development of this additional land for open space are not included in the project costs. However, it is an important part of the overall plan for the watershed.

The land treatment part of the watershed plan has been formulated on the basis of the predicted land use-almost complete residential use except for the 500 acres of open space in the upper part of the watershed. It us the land treatment objectives are: (1) to provide guidance in a progressive manner as the area moves through the transition, and (2) maintain the best possible hydrologic conditions in the watershed based on care and treatment appropriate in a suburban area.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment

Appropriate attention will be given to land treatment both during and after the project installation, (1) The town will use its influence to have subdividers use methods that will keep siltati n and rosion to a minimum during construction of residential development. (2) Builders will be encouraged to keep trees and shrubs to retain vegetative cover to the maximum practical extent. 3) The New Haven Soil and Water Conservation District will continue to pro de assistance to cooperators in planning and carrying out conservation plans on their lands. h) Encroachment on the stream will be controlled by floodplain zoning and the establishment of stream channel encroachment lines. (5) The town will cooperate with the Soil Conservation District on the open space land it acquires. Conservation plans will be developed for these areas. (6 Tome owners will be encouraged to carry out approriate soil conservation practices on their grounds. For individual owners this will involve simple small scale practices to encourage as much vegetation as possible for land cover and to provide habitat for wildlife, particularly

songbirds. (7) As the need arises, forest land treatment measures will be installed by landowners with technical assistance provided by the Connecticut State Park and Forest Commission, in cooperation with the U.S. Forest Service under the going Cooperative Forest Management Program.

Structural Measures

(All structure locations are shown on Figure 1 - Project Map).

Floodwater Retarding Structure (Site No. 2): This site requires two dams located east and west of Paradise Avenue. The east dam is located 2,500 feet north of Benham Street on the East Branch of Farm Brook and the west dam is located 500 feet north of Cooper Lane on the West Branch of Farm Brook. The dams will be about 30 feet high and will control 2.63 square miles of drainage area, with capacity to store 5.78 inches of runoff to the crest of the emergency spillways. The structure is designed with two single-stage risers and two 30 inch concrete pipe conduits, one through the embankment on each branch. A ditch approximately 2000' long within the pool area will be required on the West Branch to insure that the floodpools on each Branch fill simultaneously. At the 100-year flood stage, 85 acres will be inundated. The dams and impoundment require the relocation of ten houses. A portion of Paradise Avenue will be inundated for approximately three days during periods of maximum high water. This will not be a problem as the town has plans to relocate and extend Denslow Hill Road as a main north and south route. The installation costs are estimated at \$794,700 of which \$538,000 will be borne locally for contract administration and land acquisition.

Multiple-Purpose Floodwater Retarding-Recreation Structure (Site No. 1): This site is located on Farm Brook west of the junction of Dunbar Hill Road and Hill Street and is in series with Site No. 2. This multiple-purpose floodwater retarding-recreation structure will be about 15 feet high and will contain a 25 acre recreational pool with a maximum depth of 10 feet. The structure controls 0.47 square miles of drainage area, with capacity to store 1.80 inches of runoff to the crest of the emergency spillway. The dam is designed with a single-stage riser and 30 inch concrete pipe conduit. An eight foot berm will be constructed at the crest elevation of the single-stage riser to protect the upstream face of the dam. The dam and impoundment requires the elimination of one dairy farm. At the 100-year floodpool level, 30 acres will be inundated. The installation costs are estimated to be \$365,065 of which

\$171,317 will be borne locally for contract administration, land acquisition, construction costs, minimum basic facilities, and engineering fees for minimum basic facilities. The Town Planning Commission has prepared a preliminary plan for the development of recreational facilities at this site which provides for such activities as swimming, picnicking, boating and ice skating. These proposed minimum basic facilities include 2,000 feet of access road, parking area, bathhouse, 50 picnic tables, 35 fireplaces, dock, sanitary facilities and water supply.

The site will consist of 65 acres of which 35 acres are needed for access and minimum basic facilities.

Final plans for the recreational facilities will be provided by the Town of Hamden, subject to the approval of the Service.

Stream Channel Improvement: Approximately one mile of stream channel improvement is planned extending from the outlet of the Wilbur Cross Parkway culverts downstream into the swamp, to a point 1,370 feet below Woodin Street. Included are the replacement of the lower Brook Street Bridge, the Woodin Street Bridge, five footbridges, and the installation of a drop structure located approximately 500 feet upstream from the lower Brook Street Bridge. The channel is planned with 1:1 side slopes and bottom widths varying from 16 feet in the upper reaches to 28 feet in the lower reach. The capacity of the proposed channel ranges from 990 cfs to 1260 cfs.

EXPLANATION OF INSTALLATION COSTS

Structural Measure Costs

Cost computations for the structural measures were made at 1963 prices based on calculated quantities and estimated unit prices for construction items. The estimates were based on bid prices for structures of similar type construction and adjusted in consideration of the location, topography and foundation conditions. A contingency allowance of 20 percent was added to the engineer's estimate.

Installation services include surveys, geologic investigation, design, supervision, inspection and administrative overhead. These costs are estimated to be 32.65 percent of the construction cost of the multiple-purpose structure, 20.8 percent of the construction cost of the floodwater retarding structure, and 32.0 percent of the construction cost of the stream channel improvement. These percentages are based on costs of installing structures of comparable cost in other P.L. 566 projects in the Northeastern States.

Costs for the minimum basic facilities for recreation were prepared by the Town of Hamden Planning and Recreation Departments. Preliminary plans showing location, type and estimated cost of these minimum basic facilities were reviewed by the Administrator of the Soil Conservation Service, and preliminary approval was given to include the recreational development in this work plan.

The costs of the multiple-purpose structure are allocated to purpose by the Use-of-Facilities Method.

Land rights cost estimates were made by the Sponsor with the assistance of town officials and were based on present day market values. Consideration was given to the number of parcels and ownerships involved, contingent acquisition costs, and administrative expenses. Costs for the relocation of bridges and utilities were estimated by the Town Engineer. The costs for the land easements and rights-of-way for the minimum basic facilities for the recreational development will be cost-shared on a 50-50 basis. Funds in the amount of \$31.050 will be used to finance the Federal share of these costs. Land easements and rights-of-way costs for the multiple-purpose structure are estimated to be \$80,900, of which \$40,450 will be borne by PL-566 funds. Installation Service costs for the minimum basic facilities will be cost-shared on a 50-50 basis, \$5,000 PL-566 and \$5,000 Other, a total of \$10,000. Federal assistance will not be provided for legal and appraisal fees or the administration of contracts.

Cost Allocation by Purpose

And the second of the second o	Flood Prevention			Recreation		
4000000	PL-566	Other	Total	PL-566	Other	Total
Structure	\$29,277	\$1,036	\$30,313	\$83,421	\$79,831	\$163,252
Minimum Recreational						
Facilities				81,050	90,450	171,500
Total	\$29,277	\$1,036	\$30,313	\$164,471	\$170,281	\$334,752

The estimated schedule of total project funds for each fiscal year during the installation period is as follows:

Fiscal Year	Measure	PL-566 Funds	Other <u>Funds</u>	Total
First	Site 1 Structure Minimum Basic Facilities	\$112,698 81,050	\$80,867 90,450	\$ 193,565 171,500
Second	Site 2 Structure	256,700	538,000	794,700
Third	Bridge (Woodin Street) Bridge (Brook Street) Channel Improvement (Reach I)	34,610	41,000 46,000 21,000	41,000 46,000 55,610
Fourth	Channel Improvement (Reach III)	59,915	42,000	101,915
Fifth	Channel Improvement (Reach IV)	81,950	8,000	89,950
	TOTAL	\$626,923	\$867,317	\$1,494,240

EFFECTS OF WORKS OF IMPROVEMENT

Flood Prevention

The floodwater retarding structures, and stream channel improvements including bridge replacements, proposed in the plan will effectively control flood flows associated with a 100-year storm in Reaches I, II, III, IV, VI, VII and VIII. In Reach V, flows from a 100-year frequency storm will be reduced to the level of a three-year uncontrolled frequency storm. Damages at this level will be to lawns and basements.

Floodwater protection will be provided to 150 homes valued at \$15,000 - \$30,000 each. Approximately 3.5 miles of streets and roads will be protected.

Recreational Development

The recreational development will help meet the needs of the public by providing outdoor swimming, water associated picnicking, boating and ice skating. It is estimated that the total visitor-days will be 41,000. During the summer season it is estimated there will be 31,000 visitor-days; during the spring and fall, 3,000 visitor-days; and during the winter for ice skating, 7,000 visitor-days.

PROJECT BENEFITS

Monetary Benefits

Flood Protection: The floodwater retarding structures supplemented by channel improvements will reduce the estimated average annual monetary floodwater damages from \$114,661 to \$935, a reduction of about 99 percent. About 48 percent of the expected reduction in total average annual damage will result from the floodwater retarding structures, the remainder from the channel improvement.

The total average annual benefits as a result of the floodwater retarding structures are estimated to be \$54,592. The total average annual benefits from the channel improvements are estimated to be \$59,134. Local secondary benefits were estimated at \$10,156. Secondary benefits from a national viewpoint were not pertinent to the economic evaluation.

Recreational Development: The recreational development will be used for swimming, boating, picnicking and ice skating. It is estimated that the facilities will be used annually at the rate of 41,000 visitor-days at a value of \$1.50 per visitor-day. Thus total benefits of \$61,500 will accrue to the site annually.

Benefits Not Measured In Monetary Terms:

The project will reduce the possibility of loss of tax base due to flooding. The assessed valuation within the floodplain is approximately \$3 million.

Flood protection will enhance the commercially zoned 15 acres immediately above Benham Street. Radio and television transmitting facilities are located in the area now and the project will encourage even more intensive use.

The works of improvement will remove the threat of loss of life to the 750 people of varying ages living in the flood-prone area.

The project will prevent the floodplain becoming a blighted area because of flooding and thus will provide insurance against heavy public expenditures for urban renewal.

The recreational development will increase the desirability of the town as a place to live and thus enhance property values both in the immediate vicinity and the adjoining areas of the town. Table 7 shows project benefits by reaches.

COMPARISON OF BENEFITS AND COST

The ratio of average annual primary benefits, \$175,226, to the estimated average annual cost, \$81,881 is 2.1:1.

The total average annual benefits, including secondary benefits of \$10,156 are \$185,382. This gives a benefit-cost ratio of 2.3:1. Table 6 shows a comparison of annual costs to annual benefits.

PROJECT INSTALLATION

The structural measures proposed in this plan are planned for installation over a five-year period. The multiple-purpose structure and recreational development is planned for installation during the first year followed by the floodwater retarding structure and the stream improvement.

Federal assistance for carrying out the works of improvement on non-Federal land as described in the work plan will be provided under the authority of the Watershed Protection and Flood Prevention Act, Public Law 566 (83rd. Congress, 68 Stat. 666) as amended.

The Sponsor, the Commissioner of Agriculture and Natural Resources of the State of Connecticut, is authorized by Sections 25-106 through 25-109b of the Connecticut General Statutes to acquire land rights, construct, operate and maintain works of improvement. This includes power of eminent domain.

The Town of Hamden has the authority by town ordinance and Public Acts 350 and 535 of the 1963 General Assembly to construct, operate and maintain such works of improvement.

The Sponsor and the town both have the authority to enter into agreements for acquiring land rights to construct, operate, and maintain such works of improvement.

The Soil Conservation Service will furnish technical assistance for layout and design, preparation of plans and specifications, supervision of construction, pay the construction costs of all structural measures for flood prevention and will cost-share in the costs of the multiple-purpose structure and recreational development.

The Commissioner of Agriculture and Natural Resources is responsible for the administration of contracts, acquisition of the necessary land, easements and rights-of-way for the structural measures for flood prevention, stream channel improvement, and recreational development.

The Town of Hamden, by agreement with the Sponsor, will acquire the necessary land, easements, and rights-of-way for the installation of the stream channel improvement and Site No. 1. The town will also provide the architectural services for the design and layout of the minimum basic recreational facilities. These plans will be subject to approval by the Soil Conservation Service.

Land, easements and rights-of-way will be secured prior to the signing of a project agreement.

Technical assistance for carrying out the land treatment will be provided by a number of agencies through the respective going programs. Therefore, land treatment costs have not been included in the project costs. The Soil Conservation Service through the New Haven Soil and Water Conservation District will provide technical assistance for conservation planning and application as well as consultive type assistance. The woodland conservation help will be provided by the Connecticut Parks and Forests Commission in cooperation with the United States Forest Service under the Cooperative Forest Management Program. The Agricultural Extension Service will provide educational and informational assistance particularly in the promotion of appropriate soil and water conservation practices by suburban land owners. The Town Engineer and the Town Planner will also function very closely in the land treatment phases both during the project installation period and thereafter.

FINANCING PROJECT INSTALLATION

The Commissioner of Agriculture and Natural Resources acting under the provisions of Sections 25-106 through 25-109b inclusive and as amended by the General Statutes of Connecticut, will acquire land rights, construct, operate and maintain the proposed flood prevention works of improvement and recreational development. Funds for carrying out the Sponsor's responsibilities of these works of improvement will be provided contingent on appropriation of such funds by the State Legislature and the Town of Hamden.

The Sponsor will cost-share with the Federal government on the costs of the recreational development. The Town of Hamden will furnish the Sponsor funds for the recreational development and its share of the non-Federal costs of the proposed flood prevention works of improvement.

The Federal government will furnish funds for the construction costs of the floodwater retarding structure and the channel improvement; and will cost-share on the costs of the multiple-purpose structure and recreational development.

Federal assistance to the local organization will be contingent upon approval of the plan by Congress, the State, the Town of Hamden, and the Service. This Work Plan does not constitute a financial document to serve as a basis for the obligation of Federal and local funds. Financial and other assistance to be furnished by the Service in carrying out the Watershed Work Plan is contingent on the appropriation of funds for this purpose.

Project Installation Costs

		Federal	State	Town	Total
Flood Prevention Construction Land Rights	Site Total	\$256,700 \$256,700	\$538,000 <u>1</u> / \$538,000		\$794 ,7 00
Channel Improvement Construction Land Rights Bridges, Culver Utility Relocate Administration	rts, etc. tions, etc.	\$176,475 - - \$176,475	\$15,000 \$15,000	\$50,000 83,000 10,000 - \$143,000	\$334 , 475
Multiple-Purpose Construction Land Rights Minimum Basic I Administration	Facilities	\$ 72,248 71,500 50,000 - \$193,748	\$3,000 \$3,000	\$27,117 91,200 50,000 \$168,317	\$365 , 065
GRAND TOTAL		\$626,923	\$556,000	\$311,317	\$1,494,240

^{1/} Includes Administrative Costs.

PROVISIONS FOR OPERATION AND MAINTENANCE

The Sponsor acting under Sections 106 through 109b inclusive and as amended by the General Statutes of the State of Connecticut is responsible for the operation and maintenance of the floodwater retarding structure, the stream channel improvements and multiple-purpose structure and the recreational development included in the plan.

The Town of Hamden will operate and maintain the structures for the Sponsor through an agreement with the Sponsor. All operation and maintenance agreements will be signed prior to the issuance of invitations for bids.

The works of improvement will be inspected at least annually and after every major storm or the occurrence of any unusual adverse conditions that might affect the works of improvement. Items of inspection for the floodwater retarding structure and the multiple-purpose structure will include, but will not be limited to, the conditions of the principal spillway and its appurtenances, the emergency spillway, the earth fill and the vegetative cover of the earth fill and the emergency spillway. Items of inspection for the channel improvements will include, but will not be limited to deposition of debris, slope condition, riprap and vegetative cover.

The annual operation and maintenance cost for Site No. 2 and channel improvement is estimated to be \$8,300. Funds will be furnished by the Commissioner contingent upon appropriations by the State Legislature of funds for this purpose.

The Town of Hamden will operate and maintain the multiple-purpose structure and recreational development through agreement with the Sponsor. The annual maintenance cost is estimated to be \$15,500. This cost falls into two categories (1) Personnel - \$11,300, which includes custodial, policing, sanitation, safety and other functional services; (2) Operation including replacement of facilities with life expectancy of less than 50 years - \$4,200. To offset the cost of these items and the annual local cost of the recreational development it is expected that annual revenue will amount to \$27,500 to be derived by a daily charge to visitors of \$0.75 per visit during the summer season; \$0.25 per visit during the spring, fall and winter seasons; and concessions will bring an estimated \$2,000 annually.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Farm Brook Watershed, Hamden, Connecticut

(Dollars) 1/

			Estimated	Estimated Cost on Non-Federal Land	ederal Land
Installation Cost Item	Unit	Number	PL-566 Funds	Other	Total
STRUCTURAL MEASURES					
Soil Conservation Service Floodwater Retarding Structure	, d	-	212,500	ğ	212,500
Stream Channel Improvement Multiple-Purpose Structure		5280	133,695 18,018	711.75	133,695
Recreational Basic Facilities	្ត	!	15,000	45,000	000,06
SCS Subtotal			439,243	72,117	511,360
Installation Services					
Engineering Services Other			81,710 34,470	000°1	85,710 35,470
Subtotal Installation Services			116,180	5,000	121,180
Other Costs		A Designation of the Control of the			
Land, Easements & \mathbb{R}/\mathbb{M} Administration of Contracts			71,500	767,700 22,500	839,200 22,500
Subtotal Other		•	71,500	790,200	861,700
TOTAL PROJECT			626,923	867,317	1,494,240

1/ Price Base

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

Farm Brook Watershed, Hamden, Connecticut

Measures	Unit	Applied to date	Total Cost (Dollars) <u>l</u> /
(1)	(2)	(3)	(4)
LAND TREATMENT			
Cover Cropping	Acres	7 0	1,400.00
Tree Planting	Acres	11	600.00
TOTAL	XXX	XX	2,000.00
1/ Price base 1963		Date:	February 1964

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Farm Brook Watershed, Hamden, Connecticut

(Dollars)

Total	Installation Cost		193,565	171,500	794 , 700	334,475	867,317 1,494,240	Ø
35	Total		80,867	90,450	538,000	158,000	867,317	of bridge
Other Funds	Land Easement R/W	/6	50,750	38,950	535,000	5/ 143,0 <u>0</u> 0	767,7 <u>0</u> 0	location c
1	Adminis- tration of Contracts		3,000	1,500	3,000	15,000	22,500	for the re
Installation Costs	Install. Services	-	ı	5,000	ı	1	5,000	3,000 is
In	Constr.	1	27,117	15,000	1	1	72,117	osts, \$9
Funds	Total P.L. 566		112,698	81,050	256,700	176,475	626,923	nts. nts. of-way c
Installation Costs - P.L. 566 Fund	Land Easement R/W		10,450	1,000 31,050	1	1	71,500	land rigl
osts -	ation ces Other		17,900 6,300 40,450		13,800	13,370	34,470	sts of sents ar
lation C	Installation Services Engr• Othe			1,000	212,500 30,400 13,800	29,410	81,710	ngent congent congent congent congent congent congent congressed to the congressed t
Instal	Const.	3	810, 84	1,5,000	212,500	133,695 29,410 13,370	439,243 81,710 34,470 71,500	33 300 conti 300 conti
Structure	Site No.	Site No. 1 Multiple Purpose Flood- water Retarding Recreational Development	Structure	Minimum Basic Facilities	Site No. 2 Floodwater Retarding Structure	Stream Channel Improvement	Grand Total	 1/ Price Base 1963 2/ Includes \$10,300 contingent costs of land rights. 3/ Includes \$7,900 contingent costs of land rights. 4/ Of the total other land, easements and rights-of-way costs, \$93,000 is for the relocation of bridges

No Federal assistance will be provided on land easement, and rights-of-way costs. Includes \$7,250 specific cost for recreation-gate valve and clearing and grubbing pool area. Includes \$7,250 specific cost for recreation-gate valve and clearing and grubbing pool area.

and utilities

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TABLE 2A ESTIMATED CONSTRUCTION COST OF MINIMUM BASIC FACILITIES FOR RECREATION

SITE NO. 1

Farm Brook Watershed, Hamden, Connecticut

Item	Unit	Number	Total Cost 1
Access Road	feet	2,000	\$15,000
Bath House	no.	1	15,000
Canoe Dock	no.	ı	1,300
Sanitary Facilities	no.	2	11,200
Water Supply System	no.	1	3,500
Fireplaces	no.	3 5	2,000
Picnic Tables	no.	50	1,500
Beach Area	no.	ı	20,000
Drinking Facilities	no.	1	7,150
Service Road	no.	l	4,350
Parking Lot	ac.	2	7,000
Toll Gate	no.	1	1,000
Life Guard Tower	no.	1	1,000
TOTAL			\$90,000

1/ Price Base 1963

TABLE 3 - STRUCTURE DATA

Farm Brook Watershed, Hamden, Connecticut

ITEM	UNIT	SITE #1	SITE #21/	TOTALS
Drainage Area	sq.mi.	0.47	2.63 2	2.63
Storage Capacity	2 40			
Sediment	ac.ft.	5	28	33
Floodwater	ac.ft.	45	810	855
Recreation	ac.ft.	5 45 95 1 45	**	95
Total	ac.ft.	145	838	983
Surface Area				
Sediment Pool	ac.	bo	4	4
Floodwater Pool	ac.	30	85 85	115
Recreation Pool	ac.	25	_	25
Volume of Fill	cu.yds.	25,000	103,000	128,000
Elevation Top of Dam	m.s.l.	291.4	107.0	•
Maximum Height of Dam	ft.	15	30	
Emergency Spillway				
Crest Elevation	m.s.1.	287.7	102.0	
Bottom Width	ft.	15	350	
Type		vegetated	vegetated	
Percent Chance of Use	%	1	0.2	
Ave. Curve NoCond. II		73	78	
Emergency Spillway Hydrograph				
Storm Rainfall (6-hr.)	in.	8.0	15.3	
Storm Runoff	in.	4.8	14.4	
Velocity of Flow (Vc)	fps	5.5	7.4	
Discharge Rate	cfs	115	4,440	
Max. W.S. Elev.	m.s.l.	289.4	105.0	
Freeboard Hydrograph				
Storm Rainfall (6-hr.)	in.	13.3	25.5	
Storm Runoff	in.	9.7	22.4	
Velocity of Flow (Vc)	fps	7.2	9.6	
Discharge Rate	cfs	325	9,835	
Max. W.S. Elev.	m.s.l.	291.0	106.8	
Principal Spillway				
Capacity	cfs	63	145	
Capacity Equivalents			2	/
Sediment Volume	in.	0.20	0.24 3	/
Detention Volume	in.	1.80	5. 78	
Spillway Storage	in.	4.79	3.39	
Class of Structure		Ъ	С	
1/ In series with Site #1				

1/ In series with Site #1

^{2/} Site #2 is designed to control runoff from the total drainage area neglecting the effect of Site #1

^{3/} Sediment storage is based upon uncontrolled drainage area of 2.16 sq. miles.



Farm Brook Watershed, Hamden, Connecticut

Check 2/Vel.	6.7	7.99	channel 6.7 6.7 6.7 6.7 6.7	channel 6.2 5.3 7.5	channel 5.0 4.8 4.8
Stability Flow 5-yr.q.	L80 Bridge	1,80 1,80 Bridge	Concrete 490 490 490 190 190 540 540 Box culve	Concrete channel 540 6.2 550 5.3 550 7.5 Box culvert	Concrete 550 550 550
Rein. Con. Quan.	1 1	1 1 1	300	250	00111
Vol. of Excav. Earth	1000 252	800	300 1000 1000 600 600 of weir 1600	300 500 6000 1500	200 200 2000 1,000
Cap. at Design Depth	980	1000 1020 1030	1000 1060 1060 1060 1060 1060 1215	1230 1230 1230 1260 1260	1260 1260 1260 1260
Flow 4/ Area Chan'1.	125	154 180	98 121 134 156 189 49.40' e1	128 180 174 226	120 11,3 224 224 224
Vel. at Design Depth	6.7	× × · · · ·	10.6 8.8 7.9 6.8 5.6 6.3	2.00	0 0 0 0 0 0 0 0 0 0 0 0
Design	1.923/ 1.923/	5.95 6.72 1.883/	4.88 1.88 5.28 6.00 7.00 7.24 6.23 6.23	6.33 6.534 6.555 6.555 6.555 6.555	6.50 6.50 5.74 5.76
W.S. Elev.	65.28 65.39 65.39	64.57 64.34 62.13	61.00 58.59 57.15 56.64 56.40 149.80 t 148.70 147.14	146.98 146.50 142.35 38.32 37.80 35.80	35.60 33.98 31.70
`	0.0054 0.341	0.0033 0.0017 (2.21 head loss	0.0075 0.0075 0.0075 0.0031 0.0015 0.0027 (1.271	0.0037 0.0029 0.0035 0.0037 0.0017 (2.01	(nead loss) Concrete trans. section 1.1 0.0044 Transition section 28 2:1 0.0025
Side . Slopes	1:1	1:1 1:1 5'x10')	vert. 1:1 1:1 1:1 1:1 1:1 7'x12'bx)	20 vert. 0.00 20 1:1 0.00 20 1:1 0.00 +00 - 297+00) 20 1:1 0.00 (twin 7'x10'bx)(2.0'	(nead Concrete trans. se 16 1:1 0.00. Transition section 28 2:1 0.00
Base	20 19	#	20 20 20 20 20 20 18 20 (twin 7	20 20 20 3+00 - 2 20 (twin 7	Concr 16 Trans
Jesign	uction 0.035 g bridge	to be excavated 0.015 0.015 0.035 0.035 Existing bridge	0.045 0.015 0.050 0.035 0.050 0.035 0.050 0.035 0.050 0.035 structure 0.050 0.035	0.045 0.015 20 0.045 0.035 20 0.045 0.035 20 construction (290+00 - 0.050 0.035 20 Proposed bridge (twin	0.015 0.035 0.035 0.035
Manning's "n" Present Design	of construction 0.055 0.035 (Existing bridge	to be excavation 0.015 0.035 0.015 0.035 Existing bridge	-	0.045 0.045 0.045 construc 0.050 Propose	0.050 0.050 0.060 0.125
Req'd	!	1000	3.61 1040 3.62 1060 3.64 1060 3.65 1060 3.66 1060 Proposed drop 3.79 1215 3.79 1215	1230 1230 1230 1260 1260	1260 1260 1260 1260
D.A.	Upper 3.46 3.50	500° 500° 500° 500° 500° 500° 500° 500°	3.62 3.62 3.64 3.65 3.65 3.79 3.79	3.80 3.81 3.94 3.97 3.99	10.01 10.01 10.01
Station	253+90 254+86 255+24	257+70 259+04 259+53	261+03 264+26 266+72 263+36 270+00 270+20 274+60	276+35 278+00 290+00 297+00 300+00	301+00 301+145 304+50 313+70

Design values based on downstream stationing. Channel designed for 100-yr. frequency flow. Stability check based on 5-yr. flow and as constructed "n" values. Depth at downstream side of bridge. Flow area filled to design flow depth. ार्चिलाजा जिल्लाजा



TABLE 4 - ANNUAL COST

Farm Brook Watershed, Hamden, Connecticut

(Dollars) 1/

Evaluation Unit	: : Installation Cost :	: Operation and : Maintenance Cost :	
No. 1 Multiple-Purpose Floodwater Retarding-Recreational Development No. 2 Floodwater Retarding	\$14,190 : \$14,190 :	\$15,500 <u>3</u> /	\$29,690 :
Structure and Stream Channel Improvement	\$43,891	\$ 8,300 :	\$52,191 :
TOTAL	\$58,081 ^{2/}	\$23,800 \$23,800	: : \$81,881 :

l/ Price Base: Installation Costs-1963 Prices. Operation and Maintenance Costs-Long-Term Prices, ARS, September 1957 Price Projection.

Date: February 1964

^{2/} Amortized at 3.0 percent over 50-year period.

^{3/} Includes \$1,000 for replacement of items with life expectancy of less than 50-years.

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Farm Brook Watershed, Hamden, Connecticut
(Dollars) 1/

Item	Estimated Average And Without Project	With: Rec	nage luction nefit
Floodwater Nonagricultural	: : :	: :	
Residential	: 102,377	795 : 103	5 82
Indirect	: : 12,284 :	140 : 12 :	2,144
Total	: : 114,661 :	935 : 113 :	3 , 726

1/ Price Base Long-Term - Price Projection, ARS, September 1957

Date: February 1964

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Farm Brook Watershed, Hamden, Connecticut

(Dollars) 1/

	Average Benefit Annual Cost	29,690		52,191 2.3:1	81,881
	Total	62,888		122,494	185,382
NEFITS	Secondary Benefits	t		10,156	10,156
AVERAGE ANNUAL BENEFITS	Recreational Benefits	61,500		8	61,500
	Floodwater Damage Reduction	1,388		112,338	113,726
	Evaluation Unit	No. 1 Multiple Purpose Floodwater Retarding- Recreation Development Structure	No. 2 Floodwater Retarding	Structure and Stream Channel Improvement	GRAND TOTAL

1/ Price Base - Costs based on 1963 price level. Benefits based on long-term. Price Projection, ARS, September, 1957.

TABLE 7 - DIRECT BENEFITS FROM WORKS OF IMPROVEMENT

Farm Brook Watershed, Hamden, Connecticut

		Total Average	Annual 2/	Benefits	Dollars	19,086	64 ₉ 805	8,187	19,569	691	1,388	113,726	
ject	••	Кеу	Flood:	Damage:	Dollars	0	0	0	. 000 • 17	200	·· •• ··	935 :4,200 :	
With Project		Tow: Kev:Average	:Flood: Annual: Flood:	: Damage:Damage:	:Dollars:Dollars	0	•• •• ••	0	935	0	0	935	
	y: Peak:	. F.Tow.	:Flood:	• •	CFS:	:1260 :	:1230	: 10/10	006	320	χ χ		
	:Frequency: Peak:	or Out of	Bank	Flow	Years	T.3	H.	5.6	2.0	0.01	100.0		
	e e	: Average:Controlled:	Above:	Reach:	•• 60	. 59	. 29	72	. 22	 88	66	The Principle Committee of the Committee	
	.	•••	: Average:Co	Annual:	:Damage :	Dollars:	:980,61	: \$08,479	8,187:	20,504:	691:	1,388:	114,661:
).t	••	Κρ V	Flood	Damage:	:Dollars:Dollars:	2020 : 32,960: 19,086	:171,400: 64,805	23,700:	86,600	15,200	3,190	363,050:114,661	
Without Project		Feak	Key 1/	:Flood : Damage	CFS	2020	5080	1860	1740	1300	350		
Withou	Frequency:	of Out, of	Bank	FLOW	Years	1.0	1.0	1.2	1.0	러	1.0		
		: Drainage: Low Bank:	of Jo	Reach:	CFS	280	580	7,000	280	560	20		
		Orainage Area		Reach	Miles	to•11	5.91	3.63	3.40	2,75	0.47		
	••	• •	Danage: Above	Reach: Reach	••	 H	m	7	īV	9	ω	: Totals:	

1/ Key Flood = 100-year - 6-hour storm

2/ Secondary Benefits not shown

Date: February 1964

INVESTIGATIONS AND ANALYSES

Hydraulics and Hydrology

The procedures and criteria used in the development of the work plan are outlined in National Engineering Handbook Section 4, Hydrology, Supplement A and other Soil Conservation technical guides and memorandums.

The relationship of rainfall and its associated frequency for the watershed were derived from U.S.W.B. Technical Paper No. 29. Soil Cover Complex Numbers were computed from information furnished by Hamden Town Planner, the Soil Conservation Service, and U.S. Forest Service. This data was used to develop the storm hydrographs needed for project evaluation.

The watershed was divided into six subwatershed for the hydrologic-investigations. Synthetic hydrographs were developed for each subarea for a two-year, a ten-year, a twenty-five-year and a 100-year storm. These hydrographs were computed for present land use conditions, for future land use conditions and for future land use conditions with structures. All hydrographs were stream routed through the watershed using Wilson's Method as outlined in NEH-4. The peak discharges for each condition (land use) at each of the six damage reaches were plotted to obtain the discharge frequency curves used in the economic evaluation of the watershed.

Water surface profiles were computed for four discharges using the step method outlined in NEH-4. This data was used to develop the rating curve for each damage reach.

The 100-year floodwater detention requirements for the floodwater retarding structure were determined by procedures outlined in Technical Release No. 10. This requirement is greater than that determined by routing a 6-hour, 100-year storm. Hydrographs for emergency spillway and freeboard design were developed following the recommended criteria in E&WPU Memorandum No. EWPH-7 and in the case of emergency spillway hydrograph - meeting state criteria.

Structure Investigations

The planning investigations made of this watershed led to the selection of the two structures described in this plan as the best solution to the recreational and flood problems of Farm Brook. Of the two dams proposed, Site No. 1 will be a multiple-purpose floodwater retarding and recreation structure and Site No. 2 will be a single-purpose floodwater retarding structure.

Field Surveys: Transit and level were used in running stadia traverses on both sites for the purposes of (1) determining the storage capacity of the reservoirs, (2) obtain sufficient topographical detail in the dam and spillway areas for the work plan cost estimate, and (3) locating all buildings and other structures that exist in the proposed floodpool. The horizontal and vertical closure for the two traverses were within the allowable specified in SCS Technical Release, EWP No. 5.

Principal Spillways: Site No. 1 will have a 30" reinforced concrete pipe spillway with a standard flat top riser. The riser is provided with a pond drain at the pipe invert and a crest located at the maximum recreation pool elevation. Site No. 2 will be provided with two single-stage principal spillways, one each located on the east and west branch of Farm Brook. The two 30" principal spillways will be throttled down by orifice plates.

The crest elevations of the emergency spillways are determined by SCS Technical Paper No. 10, using the 100-year frequency runoff duration curves. (Moisture Condition II for Site No. 1 and Moisture Condition III for Site No. 2). Both structures will draw-down in less than five days from the emergency spillway crest.

Emergency Spillways: Site No. 1 is proportioned to Class "b" criteria described in SCS Engineering Memo No. 27. Site No. 2 is proportioned to State of Connecticut criteria which exceed the minimum set forth in Memo No. 27 for a "c" Hazard Structure.

Site No. 1 is planned with a 15' vegetated spillway to be excavated through a knoll between the right abutment and the stream. A 350' vegetated spillway is proposed for Site No. 2. The latter will be split up into two separate spillways, one 300' spillway on the right abutment of the east branch structure and a 50' spillway on the left abutment of the west branch structure.

The maximum feasible emergency spillway widths will be determined when final detailed site topography is available.

Cost Estimates: The quantity and cost estimates (based on current bid prices) include such items as volume of embankment, rock and earth excavation quantities, concrete and pipe quantities, clearing, grubbing and seeding. Twenty percent is allowed for contingencies on both sites.

A high pressure gas line runs parallel to Paradise Avenue through the proposed floodpool area of Site No. 2. The frequency and depth of inundation is such that it will not be necessary to relocate this utility. In addition, the telephone and power lines which bisect this area are above the proposed floodpool elevation and will not have to be relocated.

Stream Channel Improvement

The 1.0 mile of stream channel improvement included in this work plan will have sufficient capacity to carry the peak discharge associated with a 100-year event, as modified by the floodwater retarding structures, without significant flood damage.

Cost Estimates: Estimates of excavation quantities were computed from flow areas required to pass the above storm. Cost estimate items reflecting current bid prices include channel excavation and reinforced concrete quantities. Twenty percent for contingencies is provided for in the work plan estimate.

In addition the Town of Hamden has prepared the cost estimates for the replacement of the Lower Brook Street Bridge and Woodin Street Bridge. These costs include construction, engineering services and temporary relocation of utilities during construction.

Geology

Preliminary geologic investigations were conducted at the various proposed works of improvement. Visual inspection augmented by frequent soil auger borings and probings where permissible were the methods of evaluation. The area is set in a region of glaciation being primarily represented by a heterogeneous boulder till.

Preliminary investigations indicate that no critical foundation conditions are present which would adversely affect construction. Site No. 1 is a low structure crossing ground of gentle relief. No bedrock was observed at the site and no rock excavation is anticipated. At the approximate center of the proposed structure a shallow ground water table was detected with some flowing water from an abandoned well with a low artesian pressure. These ground water levels however may well reflect seasonal fluctuations.

Site No. 2 consists of two structures which abut on a drumloidal hill. No rock excavation is anticipated at either site. No low-volume weight materials were found at the east dam. A maximum of 3 feet of organic silt and muck will have to be removed from the valley floor at the west dam. Ample borrow also seems available at the sites. It is anticipated that a portion of the borrow will be excavated from the sediment pool area thus increasing the sediment capacity.

No critical engineering or construction problems are anticipated in the area of the proposed channel improvement. Likewise no problem is anticipated with side slope or channel stability in this area.

The material in the channel is predominantly a silty sand with associated gravels and cobbles. Generally the channel is stable with the above coarser fraction being quite evident from the Wilbur Cross Parkway south to the end of the proposed channel improvement. However, from the Parkway north to Benham Street the channels are primarily a very loose fine grained sand underlain by clay. These sands are in a near continual state of movement as evidenced by ripple marks and would be highly susceptible to transport under any high velocity flow i.e., in excess of 2-3 feet per second.

Economics

Damage values were based on interviews with each property owner. House values were determined and estimates were made as to the damages that would occur at intervals of one foot. The elevation of each damageable property was established and a relationship between elevation and damages was made. Relating this to stage-discharge and discharge-frequency the average annual damages and benefits by reaches were computed by the "Tabulation Method". A total of eight reaches were evaluated. Two reaches, II and VII showing no major flood problem. All damages and benefits were converted to long-term prices, using the 1957 Agricultural Research Service price projections. Costs to be incurred during the five-year installation period were based on 1963 price levels, Operation and maintenance costs were adjusted to long-term price levels.

Indirect damages were estimated to be 15% of the direct damages. These damages include loss of wages due to inability to get to work, re-routing of traffic, and interruption of utility services. Local secondary benefits were estimated to be 10% of the direct primary benefits and were used for project evaluation. Secondary benefits from a national viewpoint were not pertinent to the economic evaluation.

The town officials stated that without protection the area would drop in value; there would be a tax loss, and eventually there would be a need for urban renewal.

Damages and benefits were computed with and without the project up to and including the 100-year frequency event.

Land rights were evaluated by the Sponsor, and the Town of Hamden, and include the cost of property surveys, legal fees, appraisals, court costs and payments to the property owners. The property estimates were based on present day market values. Operation and maintenance costs were estimated by the Sponsor based on actual cost of operating and maintaining similar structures.

Recreational benefits were estimated by the Town Planner, the Town Recreational Department and the Service. Estimated visitor days were based on the need for the kind of recreation to be provided, the capacity of the facilities, length of seasons, and normal weather conditions. A visitor—day is a visit by one person to the recreation site during one day regardless of how long he stays or what kind of recreation he participates in.

During the summer season, June, July and August, the estimates were based on an average of about 415 visitors a day for 75 days or 31,000 visitor-days. The estimate for the spring and fall season is about 200 visitors per day for 15 days or 3,000 visitor-days. Recreational Department records indicate an expectation of about 14 skating days each winter and that a facility of this size would expect about 500 visitors a day or 7,000 visitor-days for the winter skating season.

It is estimated that the total annual visitor-days will be 41,000. A value of \$1.50 per visitor-day was used to determine the mone tary benefits based on fully developed facilities. This benefit is \$61,500 annually.





